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Internal Distribution

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External Distribution

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MERIS level 3 cloud and water vapour products

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1 INTRODUCTION

Clouds and atmospheric water vapour have significant impact on the Earth's radiation budget and on the energy and water cycle. Exact knowledge about cloud parameters and water vapour is therefore prerequisite for climatological investigations as well as for numerical weather prediction models e. g. in order to validate cloud parameterization schemes.

Most common in climate research is the ongoing International Satellite Cloud Climatology Project (ISCCP, e. g. Schiffer and Rossow, 1983; Rossow et al., 1991) that provides global data on a monthly average as well as on a three-hourly basis with a horizontal resolution of 50 km and 280 km, respectively.

MERIS will contribute to both research areas by providing estimates of atmospheric water vapour content, cloud top pressure, and cloud optical depth. For each overpass these parameters will be retrieved with the full MERIS resolution of 300 m at nadir.

2 ALGORITHM OVERVIEW

Within the German MERIS processor monthly and weekly averaged cloud and water vapour products will be generated. These products are derived from MERIS level 2 cloud optical thickness, cloud top pressure, and columnar water vapour content. Two different products will be generated based on these data:

1. A coarse cloud classification solely based on cloud optical depth and cloud top pressure will be applied. Similar to the ISCCP cloud classification (e. g. Rossow et al., 1991) nine different classes of clouds and one cloud-free class will be distinguished. Weekly and monthly averages and variances of cloud frequency, cloud optical depth, and cloud top pressure will be provided for each class.
2. A second product will provide data on a dense vertical grid without an explicit classification of cloud type. The vertical grid resolution will be 50 hPa where each level 2 data will be grouped according to the derived cloud top pressure. In addition to the cloud products a

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water vapour product will be provided in the same grid. This product consists of average columnar water vapour content and its variance above each cloud layer.

The horizontal resolution of both products will be $4.8 \times 4.8 \text{ km}^2$. This resolution is a compromise between the demand of high-resolution information and numerical and practical considerations. While the resolution is still sufficient to compare even to high resolution numerical weather prediction models, the investigation area is covered by a 1250×1250 array of data for each variable and thus the dataset is manageable. Table 1 provides an overview of the data derived within both level 3 products.

Table 1: MERIS Level 3 cloud and water vapour products overview. The numbers refer to the aforementioned different categories of level 3 products.

Name	Average	Variance	No. of Measurements
Fractional cloud cover	1,2	1,2	1,2
Cloud top pressure	1,2	1,2	1,2
Cloud optical depth	1,2	1,2	1,2
Water vapour content	2	2	2

3 ALGORITHM DESCRIPTION

1.1 ISCCP-Compatible product

Figure 1 depicts the ISCCP cloud classification. Within ISCCP nine different classes of clouds are identified according to their optical depth and cloud top pressure. Although the synoptic classification in different cloud types is somewhat arbitrary and largely depends on the scale on which the clouds are observed, its value in global and regional cloud studies has been demonstrated in various studies.

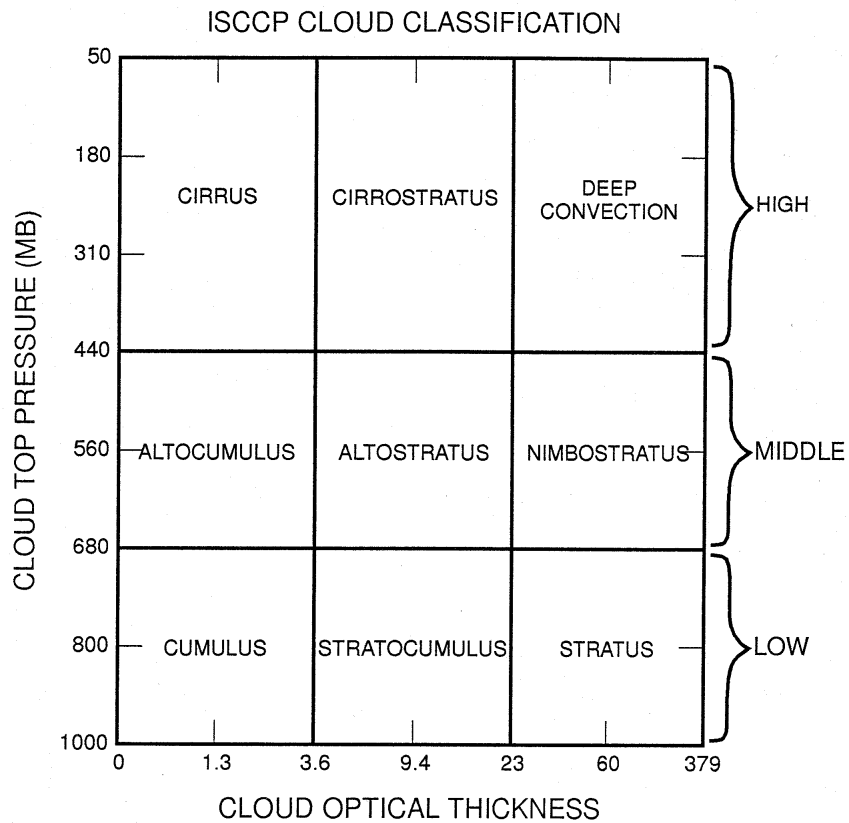


Figure 1: ISCCP cloud classification according to Rossow et al. (1991).

The ISCCP-classification is easy to adapt for MERIS, since the two parameters on which the classification is based, are cloud optical thickness and cloud top pressure, both available on MERIS processing level-2. In addition, since cloud/no-cloud flags are provided, a cloud-free class will be introduced, allowing for the calculation of cloud-frequency, thus cloud classes

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ranging from 1 to 10. For a given $4.8 \times 4.8 \text{ km}^2$ box, N valid MERIS-observation within this box, the following parameters will be calculated for each overpass:

$$N^K = \text{number of observations in cloud class } k, k = 1, \dots, 10 \quad (1)$$

$$N^{TOT} = \sum_{k=1}^{9!} N^K \text{ total number of cloud observations} \quad (2)$$

adding class 10 (cloud - free) obviously yields :

$$N^{TOT} + N^{10} = N \quad (3)$$

$$C^K = N^K / N \text{ cloud frequency in class } k, k = 1, \dots, 10 \quad (4)$$

$$C^{TOT} = N^{TOT} / N \text{ total cloud cover} \quad (5)$$

$$\langle CTP^K \rangle = \text{MEAN}(CTP_i \text{ in cloud class } k); \text{ average CTP in class } k \quad (6)$$

$$VAR_CTP^k = \text{Variance}(CTP_i \text{ in cloud class } k); \text{ variance CTP in class } k \quad (7)$$

$$\langle COD^K \rangle = \text{MEAN}(COD_i \text{ in cloud class } k); \text{ average COD in class } k \quad (8)$$

$$VAR_COD^k = \text{Variance}(COD_i \text{ in cloud class } k); \text{ variance COD in class } k \quad (9)$$

where upper indices denote the respective cloud classes derived from the thresholds in cloud optical depth (COD) and cloud top pressure (CTP) as given in Figure 1 and lower indices denote MERIS level 2 measurements of cloud properties (Fischer et al., 1998 a,b). Monthly and weekly averages and standard deviations of variables defined in variables (4) to (7) are calculated as MERIS level-3 products and the cumulative sum of the variables defined in Equations (1) and (2) is stored as well. This information will allow to calculate subsequent statistics on all fields.

1.2 High vertical resolution product

In addition to the product described in section 1.1 a high vertical resolution cloud product will be derived. While no cloud classification is applied, this product serves to identify cloud and atmospheric properties associated with different cloud top heights. The vertical resolution of this product will be 50 hPa, starting at 1000 hPa down to 50 hPa, this leads to 19 cloud top height classes. For each of these classes the aforementioned parameters (Eq.(1),(2),(4)-(7)) will be stored and in addition the following water vapour parameters will be derived from the level 2 data (Fischer and Bennartz 1998):

$$\langle WVP^K \rangle = \text{MEAN}(WVP_i \text{ in cloud class } k); \text{ average WVP in class } k \quad (10)$$

$$VAR_WVP^k = \text{Variance}(WVP_i \text{ in cloud class } k); \text{ variance WVP in class } k \quad (11)$$

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4 CONCLUSIONS

The MERIS level 3 products described in this document will allow for detailed climatological investigations of atmospheric properties, such as frequency and optical depth of clouds at different altitudes as well as of typical distributions of water vapour in cloudy and cloud-free atmospheres. In terms of the definition of different cloud types the dataset will be compatible with existing data products, but it will be provided with a much higher horizontal and vertical resolution. Thus, the dataset may not only provide an independent source for validation and improvement of existing datasets, it will also serve for detailed studies of regional cloud climate with a resolution better than 5 km.

5 REFERENCES

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